

IN THE SPECIFICATION

Please amend the paragraph beginning at page 3, line 30, as follows:

A media source to solve the described object according to a first embodiment is defined in ~~claim 33~~ a first aspect of the invention, and a media sink is defined in ~~claim 37~~ a second aspect of the invention. Further, a corresponding method according to the first embodiment is defined in ~~claim 40~~ a third aspect of the invention. Preferred embodiments thereof are respectively defined in ~~the respective following subclaims~~ further aspects. A media source, a media sink, a media processing system, and corresponding methods to solve the described object according to a second embodiment are also described herein.

Please amend the paragraph beginning at page 10, line 29, as follows:

For clocks, it is assumed that in a media-streaming device two clocks are available (accessible): the sample clock and the global wallclock. The sample clock is the clock that is inherent in the media stream. For a CD as an example of a source of an audio stream this sample clock is running with 44.1 kHz. The global wallclock can be read by all source and sink devices participating in a media session. For IP networks, the Network Time Protocol (NTP) describes how a NTP clock can be maintained throughout a network. However, for applications with tight requirements, such as synchronizing two stereo channels, the accuracy and clock resolution of such an NTP clock may not be sufficient. Therefore it is assumed that a clock with much higher accuracy and resolution is available. This is the case in some wireless systems that need a common clock among all peers in order to execute a synchronized frequency hopping. One example for such a wireless system is given according to the BLUETOOTH ~~(IEEE 802.15.4)~~ specification, where all participants of a piconet maintain a common clock. The time of the common clock can be used by media applications as the global wallclock time. Usually, the sample clock time and the global wallclock time

are measured in different units. For example, the global wallclock may tick in units of microseconds, whereas the sample clock may tick in units of single samples as smallest unit.

Please amend the paragraph beginning at page 11, line 33, as follows:

In Figure 2 the assumption is made that there is a global wallclock time 201 available to the media source 202 and all n media sinks, i.e. media sinks 203-1, 203-2, ..., 203-n. This global wallclock time can for example be the time of the clock that is used by digital bus systems or wireless digital transmission systems. Furthermore, it is assumed that this clock fulfills the requirements in terms of accuracy and resolution concerning the desired synchronization. Typically, such a clock is located very close to the physical layer, e.g. in the baseband of such a transmission system. For general-purpose devices like a PC or a PDA 202, this means that such a clock is external and can only be accessed via an external connection 204, e.g. USB or RS232. One example for this is a BLUETOOTH (~~IEEE 802.15.1~~) module that is connected to a PC via USB. The BLUETOOTH (~~IEEE 802.15.1~~) baseband clock is synchronized automatically by all devices within a piconet, because this clock information is used to synchronize the frequency hopping of all piconet participants. The native BLUETOOTH (~~IEEE 802.15.1~~) clock information then has to be transported from the BLUETOOTH (~~IEEE 802.15.1~~) module to the PC via the USB bus system.

Please amend the paragraph beginning at page 15, line 29, as follows:

Figure 4 shows a possible scenario where the procedure according to the invention can be applied. A BLUETOOTH (~~IEEE 802.15.1~~) equipped PC 400 is multicasting a stereo audio stream in form of media data packets to two BLUETOOTH (~~IEEE 802.15.1~~) loudspeakers, i.e. a first BLUETOOTH (~~IEEE 802.15.1~~) loudspeaker 4021 and a second BLUETOOTH (~~IEEE 802.15.1~~) loudspeaker 4022, via two BLUETOOTH (~~IEEE 802.15.1~~)

links, i.e. a first BLUETOOTH (IEEE 802.15.1) link 4011 and a second BLUETOOTH (IEEE 802.15.1) link 4012. In each link the media data packets of one audio signal of a stereo signal are transmitted to the respective loudspeaker.

Please amend the paragraph beginning at page 16, line 3, as follows:

The BLUETOOTH (IEEE 802.15.1) module on the PC 400 is connected via USB, whereas in the first BLUETOOTH (IEEE 802.15.1) loudspeaker 4021 and the second BLUETOOTH (IEEE 802.15.1) loudspeaker 4022 BLUETOOTH (IEEE 802.15.1) is embedded directly into the system design. The global wallclock time to be used by the PC and the BLUETOOTH (IEEE 802.15.1) loudspeakers is the BLUETOOTH (IEEE 802.15.1) baseband clock inherent in each BLUETOOTH (IEEE 802.15.1) baseband implementation. This BLUETOOTH (IEEE 802.15.1) baseband clock is very well synchronized among all participants of a BLUETOOTH (IEEE 802.15.1) piconet.

Please amend the paragraph beginning at page 16, line 10, as follows:

The PC 400 as the media source of the audio stream starts with evaluating the quality and delay of the BLUETOOTH (IEEE 802.15.1) transmission to the first BLUETOOTH (IEEE 802.15.1) loudspeaker 4021 and the second BLUETOOTH (IEEE 802.15.1) loudspeaker 4022 using the information that is provided by the control packets as defined in RTP. Further, the PC queries the time needed for decoding and the buffer capabilities from each speaker using appropriate signaling commands. With this information and the random variation of the clock information of the PC, i.e. a maximum possible variation, the PC can determine a play-out time offset. This play-out time offset is transmitted to the first BLUETOOTH (IEEE 802.15.1) loudspeaker 4021 and the second BLUETOOTH (IEEE 802.15.1) loudspeaker 4022 once and is added to the time indicated by the timestamp of each

media data packet of a media stream to get the common play-out time for each media data packet. In an alternative embodiment of the invention, a common play-out time may be determined by the media source, here the PC 400, for each media data packet and then transmitted together with each media data packet, as described in connection with Fig. 6 below.

Please amend the paragraph beginning at page 16, line 25, as follows:

The PC 400 as the media source of the stream creates the timestamps. When RTP media data packets are sent, the timestamps in the media data packets describe the moment in time the packet was created in time units of the sample clock. The link to the global wallclock time, here the BLUETOOTH ~~(IEEE 802.15.1)~~ baseband clock, is achieved by supplying two timestamps for the same moment in time in the RTCP control packets, one timestamp indicating the moment in time in units of the sample clock and the other one in units of the global wallclock, as described above. Because of the inaccuracy of the clock information available on the PC side, however, the baseband clock is preferably actually read only for the first control packet. For consecutive control packets, the time information for the global wallclock timestamp is created by counting the number of samples passed since the last control packet and then translating this number of samples into time in units of the global wallclock. As mentioned above, a control packet has a global wallclock timestamp indicating a moment in time in time units of the global wallclock time and a sample clock timestamp indicating the same moment in time in time units of the sample clock time. Therefore, by combining the information provided by the various timestamps present in the media data packets and the control packets, each BLUETOOTH ~~(IEEE 802.15.1)~~ loudspeaker can determine the moment in time at which a packet was created by the source in time units of the global wallclock time from the timestamp of a media data packet, which indicates the time of

creation in time units of the sample clock. By adding the negotiated play-out time offset, it is then determined when the samples from each media data packet have to be played-out. Because each sink can access the BLUETOOTH ~~(IEEE 802.15.4)~~ baseband clock directly, all sinks are able to synchronize their sample play-out clocks tightly to the BLUETOOTH ~~(IEEE 802.15.4)~~ baseband clock.

Please amend the paragraph beginning at page 17, line 16, as follows:

Because the clock information is imprecise to a certain extent on the source side, the first BLUETOOTH ~~(IEEE 802.15.4)~~ loudspeaker 4021 and the second BLUETOOTH ~~(IEEE 802.15.4)~~ loudspeaker 4022 as the media sinks of the audio have to compensate for this inaccuracy with a suitable buffer size. For example, the PC 400 knows that the clock information has a maximum variation of 2 ms. Therefore, in order to avoid the situation that the play-out time of a media data packet has already elapsed once the media data packet reaches the sink it includes these 2 ms in the negotiated play-out time offset. With 2 ms variation, the timestamps created by the source will be 1 ms too early or 1 ms too late in the worst case. Therefore, the sinks have to provide enough memory to buffer the data for this worst-case period that is always added by the source device in order to be on the safe side.

IN THE CLAIMS

Please amend the claims as follows:

1-32. (Canceled).

33. (Previously Presented) A media source, comprising:

a global clock determination unit configured to determine, once within a session, a global wallclock time having a first statistical variation;

a sample clock determination unit configured to determine a sample clock time;

a communications unit configured to send out, only once within the session, a control packet to one or more receiving media sinks, said control packet including two control packet timestamps, one of the control packet timestamps defining a moment in time in time units of said global wallclock time, another of the control packet timestamps defining the moment in time in time units of said sample clock time;

a sending unit configured to send out time-stamped media data packets to the one or more receiving media sinks, each of the time-stamped media data packets including a timestamp that is a time of creation of the time-stamped media data packet;

a determining unit configured to determine a play-out time offset based, in part, on the first statistical variation; and

a transmission unit configured to send out the play-out time offset to said one or more receiving media sinks once for all time-stamped media data packets of the session.

34. (Canceled).

35. (Previously Presented) The media source according to claim 33, wherein the sending unit is configured to send out the time-stamped media data packets, wherein each

timestamp is the time of the creation of the respective time-stamped media data packet in the time units of said sample clock time.

36. (Previously Presented) The media source according to claim 33, wherein said sending unit is configured to send out the same time-stamped media data packets to two or more different receiving media sinks.

37. (Previously Presented) A media sink, comprising:

a receiving unit configured to receive a control packet, time-stamped media data packets, and a play-out time offset from a media source, the control packet including two control packet timestamps, one of the control packet timestamps defining a moment in time in time units of a global wallclock time, another of the control packet timestamps defining the moment in time in time units of said sample clock time, the global wallclock time having a statistical variation, the play-out time offset being received once for all time-stamped media data packets of a session;

a determining unit configured to determine the global wallclock time;

an addition unit configured to determine a common play-out time of one of the time-stamped media data packets by adding a time, which is a timestamp included in the one of the time-stamped media data packets, and the play-out time offset; and

a play-out unit configured to play-out the one of the time-stamped media data packets when the determined common play-out time of the one of the time-stamped media data packets is reached, wherein

the receiving unit is configured to receive the play-out time offset, which is based, in part, on the statistical variation.

38. (Previously Presented) The media sink according to claim 37, further comprising:
a conversion unit configured to convert the time, which is defined in the time units of said sample clock time, into a time defined in the time units of the global wallclock time, based on the two control packet timestamps.

39. (Previously Presented) The media sink according to claim 37, further comprising:
a buffer configured to store the time-stamped media data packets until said common play-out time is reached.

40. (Previously Presented) A method, implemented by a media source, for
synchronously playing-out media data packets, the method comprising:
determining, once within a session, at the media source, a global wallclock time having a statistical variation;
determining a sample clock time;
sending out, only once within the session, a control packet to one or more receiving media sinks, said control packet including two control packet timestamps, one of the control packet timestamps defining a moment in time in time units of said global wallclock time, another of the control packet timestamps defining the moment in time in time units of said sample clock time;
sending out time-stamped media data packets to said one or more receiving media sinks, each of the time-stamped media data packets including a timestamp, the timestamp being a time of creation of the time-stamped media data packet;
determining, at the media source, a play-out time offset based, in part, on the statistical variation; and

sending out the play-out time offset to said one or more receiving media sinks once for all time-stamped media data packets of the session.

41. (Canceled).

42. (Previously Presented) The method according to claim 40, wherein, in the sending out the time-stamped media data packets, the timestamp is the time of the creation of the one of the time-stamped media data packets in the time units of said sample clock time.

43. (Previously Presented) The method according to claim 40, wherein the sending out the time-stamped media data packets includes sending out the same time-stamped media data packets to two or more different receiving media sinks.

44. (Previously Presented) The media source according to claim 33, wherein the determining unit is configured to determine the play-out time offset, which is a basis for determining, for the one of the time-stamped media data packets, a play-out time for playing out content included in the one of the time-stamped media data packets at said one or more receiving media sinks, said play-out time being determined based on adding the play-out time offset to the time of the creation of the one of the time-stamped media data packets.

45. (Previously Presented) The media source according to claim 33, wherein the sending unit is configured to send out the time-stamped media data packets, each of the time-stamped media data packets including media data; and the global wallclock time is provided to the media source and said one or more receiving media sinks.

46. (Previously Presented) The media source according to claim 33, wherein the sample clock time corresponds to media data included in the time-stamped media data packets; and

the global wallclock time is provided to the media source and said one or more receiving media sinks.

47. (Previously Presented) The media sink according to claim 37, wherein the time-stamped media data packets include media data.

48. (Previously Presented) The media sink according to claim 38, wherein the sample clock time corresponds to media data included in the time-stamped media data packets.

49. (Previously Presented) The method according to claim 40, further comprising:

determining, for the time-stamped media data packets, a play-out time for playing out content included in the time-stamped media data packets at said one or more receiving media sinks, the play-out time being determined based on adding the play-out time offset to the time of the creation of the respective time-stamped media data packets.

50. (Previously Presented) The method according to claim 40, wherein

in the sending out the time-stamped media data packets step, the time-stamped media data packets include media data; and

the global wallclock time is provided to the processor and said one or more receiving media sinks.

51. (Previously Presented) The method according to claim 40, wherein

in the determining the sample clock time step, the sample clock time corresponds to media data included in the time-stamped media data packets; and

in the determining the global wallclock time step, the global wallclock time is provided to the media source and said one or more receiving media sinks.

52. (Previously Presented) A system, comprising:

a media source including,

a global clock determination unit configured to determine, once within a session, a global wallclock time having a statistical variation;

a sample clock determination unit configured to determine a sample clock time;

a communications unit configured to send out, only once within the session, a control packet to one or more receiving media sinks, said control packet including two control packet timestamps, one of the control packet timestamps defining a moment in time in time units of said global wallclock time, another of the control packet timestamps defining the moment in time in time units of said sample clock time;

a sending unit configured to send out a time-stamped media data packet to a media sink, the time-stamped media data packet including a timestamp that is a time of creation of the time-stamped media data packet,

an offset determining unit configured to determine a play-out time offset, based, in part, on the statistical variation, and

a transmission unit configured to send out the play-out time offset to the media sink once for all time-stamped media data packets of the session,

the media sink including,

a receiving unit configured to receive the time-stamped media data packet and the play-out time offset from the media source, the play-out time offset being received once for all time-stamped media data packets of the session,

a determining unit configured to determine the global wallclock time,

an addition unit configured to determine a common play-out time of the time-stamped media data packet by adding the play-out time offset and the time of the creation of the time-stamped media data packet, and

a play-out unit configured to play-out the time-stamped media data packet when the determined common play-out time of the time-stamped media data packet is reached.

53. (Previously Presented) The system according to Claim 52, wherein the media source includes a sample clock determination unit configured to determine the sample clock time, the sample clock time corresponding to media data included in the time-stamped media data packet.

54. (Previously Presented) The system according to Claim 53, wherein the sending unit is configured such that said timestamp is the time of the creation of the time-stamped media data packet in the time units of said sample clock time.

55. (Previously Presented) A method, implemented by a media source and one or more receiving media sinks, the method comprising:

determining, once within a session, at the media source, a global wallclock time having a statistical variation;

determining a sample clock time;

sending out, only once within the session, from the media source, a control packet to the one or more receiving media sinks, said control packet including two control packet timestamps, one of the control packet timestamps defining a moment in time in time units of said global wallclock time, another of the control packet timestamps defining the moment in time in time units of said sample clock time;

sending out a time-stamped media data packet to the one or more receiving media sinks, the time-stamped media data packet including a timestamp that is a time of creation of the time-stamped media data packet;

determining, using a processor of the media source, a play-out time offset based, in part, on the statistical variation;

sending out the play-out time offset once for all time-stamped media data packets of the session;

receiving the time-stamped media data packet and the play-out time offset, the play-out time offset being received once for all time-stamped media data packets of the session;

determining the global wallclock time at the one or more receiving media sinks;

determining a common play-out time of the time-stamped media data packet by adding the play-out time offset and the time of the creation of the time-stamped media data packet; and

playing the time-stamped media data packet when the determined common play-out time of the time-stamped media data packet is reached.

56. (Currently Amended) The media source according to claim 33, wherein the play-out time offset is used at the one or more receiving media sinks as a basis for determining, for each of the media data packets, a common play-out time based on the global wallclock time,

the common play-out time of a certain media data packet being used for playing out the certain media data packet at the common play-out time at each of the one or more media sinks, the global wallclock time being determined at each of the one or more receiving media sinks with a second statistical variation, the second ~~random~~ statistical variation being smaller than the first statistical variation.

57. (Currently Amended) The media source according to claim 33, wherein the global clock determination unit is configured to determine the global wallclock time from a baseband clock conforming to ~~an IEEE 802.15.1 standard~~ an IEEE 802.15.1 standard BLUETOOTH; and the communications unit is configured to send out the control packet including the two control packet timestamps, the one of the control packet timestamps defining the moment in time in time units of the baseband clock conforming to ~~the IEEE 802.15.1 standard~~ BLUETOOTH.